SDLX100 - Transient response of a plate at a field of pressure resulting from ENSIGHT

Summarized:

The domaine d'application of this test relates to the dynamics of structures, and more particularly the computation of linear transient response direct at a field of pressure evolving in time, defined in files with ensight format. It understands a modelization.

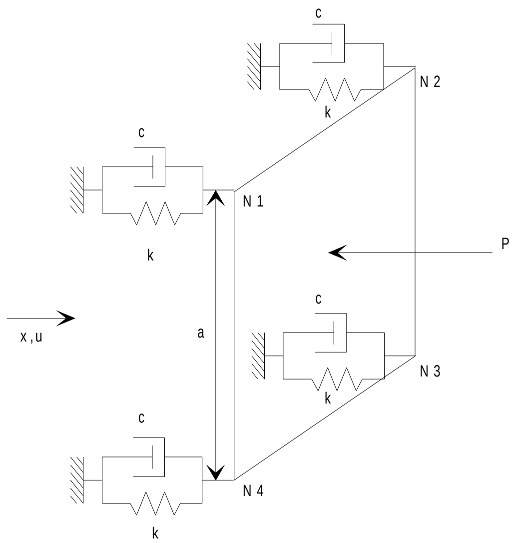
It is a question of calculating the response of a shell element pressed in its 4 nodes on 4 stiffness and dampers, with a sinusoidal pressure defined in the four nodes.

This test makes it possible to validate the tools of definition of loading of pressure from files to ensight format and computation of direct transient response to this loading.

The got results are in very good agreement with the analytical reference solution.

1 Problem of reference

1.1 Geometry



Plates side $a=1.m$, of thickness $e=1.282E-04\,m$
Stiffness: k
Viscous dampings: c

1.2 Material properties

Material of the plate:

$$E=2.1\,10^{11}\,Pa \qquad \nu=0.3 \qquad \rho=7800\,kg/m^3$$

Comes out from linear elastic translation one-way: $k=9.8696E+4\,N/m$
One-way viscous damping: $c=3.1416\,N/(m/s)$

These values correspond to a reduced damping of $1\,\%$ on the first mode of structure.

1.3 Boundary conditions and loadings

sinusoidal uniform Pressure applied to the plate along the axis x , defined by a value in the four nodes:

$P=P_0 \sin\omega t \quad \omega=2\pi f \qquad f=100\,Hz=$ first eigenfrequency of the system.

$P_0=constante \quad =1\mathrm{N}/m^2$ that is to say a total force on the plate $F_0=a^2 P=1\mathrm{N}$

1.4 Initial conditions

Structure initially at rest.

2 Reference solution

2.1 Method of calculating used for the reference solution

the simple oscillator checks the following equation:

$$m\ddot{u}+c\dot{u}+ku=F_0\sin(\omega t)$$

with $u(0)=0$ and $\dot{u}(0)=0$

ω : own pulsation of the oscillator $\omega=\sqrt{\frac{k}{m}}$

The damping criticizes is $c_{critique}=2m\omega$.

The solution for a subcritical damping such as $\frac{c}{c_{critique}}=\xi$ is:

$$u(t)=e^{-\xi\omega t}\left(\frac{F_0}{2\xi k}\cos(\omega_D t)+\frac{F_0\omega}{2\mathrm{k}\,\omega_D}\sin(\omega_D t)\right)-\frac{F_0}{2\xi k}\cos(\omega t)$$

with $\omega_D=\omega\sqrt{1-\xi^2}$

2.2 Results of reference

Displacement according to x point $N1$.

2.3 Uncertainty on the analytical

solution Solution.

3 Modelization A

3.1 Characteristic of the modelization

Shell element DST
Discrete elements:

DISCRET: with stiffness matrixes in translation K_T_D_N
and damping matrixes A_T_D_N

Names of the nodes: $N1$ $N2$, $N3$ and $N4$

Loading of pressure contained in the directory sdlx100a.ensi: square

_m.result: many

- times of definition of the pressures: 200 times
- of definition of the pressures: (, $n*\Delta t$) $\Delta t=2.5\text{E}-04$ name $n=0,199$ of
- the file containing the affected nodes of a pressure: carre_measured.geom root of
- the names of the files containing the value of the pressures for each time step: pressure. *** carre_measured.geom

: coordinated nodes, and where $N1$ $N2$ $N3$ the pressure $N4$ pression.n is defined (pressure **.000** with pression.199): file containing

the values of pressure to the 4 nodes with. Direct $t=n*\Delta t$

transient computation: Time step used
Integration NEWMARK $\Delta t=1.\text{E}-4s$
, Characteristic $\alpha=0.25$ $\delta=0.5$

3.2 of the mesh Many nodes

= 4 Number of meshes
and type = 1 QUAD4 Quantities tested

3.3 and results Time Reference

Aster (s)	Difference (m)	(% (m)	) 0.005 3,917E-
06 3.906	E-06 –	0.28 0.015	1,139E-
05 1.136	E-05 –	0.26 0.025	1,841E-
05 1.836	E-05 –	0.27 0.035	2,500E-
05 2.493	E-05 –	0.28 0.045	3,119E-
05 3.111	E-05 –	0.25 Summary	of

4 the results the results

of analytical reference are found with a very good accuracy (less of variation). 0.3%